

REMARKS

A. Status of the Claims

In the Office Action of August 21, 2009, the status of the claims was as follows:

Claims 1-32 were cancelled.

Claims 33-55 were rejected on various grounds.

In this Amendment and Response, Claims 33-55 have been cancelled and replaced with new Claims 56-70. Accordingly, the previous grounds of rejection are considered moot. As discussed below, no new matter has been added. For the reasons discussed below, Applicants respectfully submit that new Claims 56-70 meet the requirements of Sec. 112 and also distinguish over the cited prior art, whether those references are taken individually or in combination.

B. Support for New Claims

1. Corrected Chemical Formulas

In independent Claims 56, 61, 63 and 67, the general chemical formula representing the claimed iridium compounds has been corrected in accordance with accepted chemical practice. As the result of an unintentional typographical error in the original Specification and the earlier claims, the general chemical formula representing the claimed iridium compounds was depicted with each of the four oxygen (O) atoms having three chemical bonds to other atoms. As is well recognized in this art, oxygen atoms normally only form two chemical bonds. Accordingly, in the corrected general chemical formula of this Amendment and Response, the oxygen atoms are shown correctly as forming two chemical bonds. Applicants respectfully

submit that this correction of an obvious typographical error does not constitute new matter.

2. Vacuum Evaporation Step

New Claim 56, and some of the other new claims, reference the method step of forming an electroluminescent layer of the claimed iridium compound by “vacuum evaporating” the material onto a substrate, as illustrated in Fig. 17 and as described in the “Device construction” description at page 20, line 19 to page 21, line 4.

3. L₁ and L₂

The recitation in the new claims of “L₁” and “L₂” as being selected from the group consisting of “phenyl pyridine and substituted phenyl pyridines” is supported by original (now-canceled) Claim 3.

4. R₁ to R₄

The recitation in the new claims identifying “R₁ to R₄” is supported at page 2, lines 12-24, of the Specification.

The more specific recitation in new Claim 57 concerning “R₁ to R₄” is supported at page 3, lines 1-4.

5. Mixture of Electroluminescent Materials / Layers of Different Electroluminescent Materials

New Claims 59-62 recite electroluminescent layers in which the iridium compound is mixed with a second electroluminescent material or wherein there is a layer of the iridium compound and a layer of a second electroluminescent material. These claim recitations are supported at page 9, lines 9-23 of the Specification.

The specific recitation in new Claim 60 that the second electroluminescent material is CBP is supported in the example of "Device construction" at page 20, line 26 to page 21, line 2 of the Specification, and also by Fig. 4b as referenced in the "Device construction" example.

The specific recitation in new Claim 62 concerning the europium complex is supported by original Claim 15 (now cancelled) and Claim 41 (now cancelled).

Applicants confirm that the Examiner's interpretation of the recited europium complex in paragraph 3 of the last Office Action is correct.

6. Method of Preparation

New Claims 63-66 directed to methods of preparing iridium compounds according to this invention are supported by the preparation examples at page 18, line 14 to page 20, line 17 of the Specification.

7. Claim 70

New Claim 70 is supported by the table of Fig. 19 of the application.

C. Amendment of the Specification / Brief Description of the Drawings

In response to the objection in paragraph 1 of the Office Action, this Amendment and Response amends the Specification to add a “Brief Description of the Drawings” section. No new matter has been added. The “Brief Description of the Drawings” is based on the way these drawings are described in the Specification and how these figures would reasonably be interpreted by one of ordinary skill in this art viewed in conjunction with the entire application.

D. Sec. 112 Rejection

In paragraph 2 of the Office Action, Claims 33-55 were rejected under 35 U.S.C. §112, second paragraph, as being indefinite in various respects. Claims 33-55 have been cancelled. Applicants respectfully submit that new Claims 56-70 meet the requirements of §112.

E. Claim Interpretation

Applicants confirm that the Examiner’s interpretation of the chemical term “Eu(DBM)₃OPNP” in paragraph 3 of the Office Action is correct.

F. Sec. 102 Rejection – Tsuboyama ‘802

In paragraphs 4 and 5 of the Office Action, Claims 33-37, 42-44, 46-51 and 53-55 were rejected under 35 U.S.C. §102(e) as being anticipated by U.S. Pat. Publ. No. 2003/0152802 (Tsuboyama ‘802). All of these rejected claims have been cancelled herein and replaced by new Claims 56-70. Applicants respectfully submit that new Claims 56-70 are not anticipated by Tsuboyama ‘802.

1. Scope of Tsuboyama '802

Tsuboyama '802 is directed to a class of what are called “metal coordination compound[s] having a binuclear molecular structure” according to a general chemical formula (formula (1) at paragraph [0029]). These compounds are posited to be useful as the luminescence material in “an organic luminescence device exhibiting a long life and a high luminescence efficiency.” The Tsuboyama '802 disclosure is drafted expansively to encompass hundreds of different such “metal coordination compounds” as represented by the general chemical formula. Indeed, Tsuboyama '802 specifically lists 760 possible such compounds based on various combinations of substituents for the several generic elements of the general chemical formula, and many others would be theoretically possible consistent with the teachings of Tsuboyama '802.

2. Narrow and Limited Representative Examples in Tsuboyama '802

While expansive in its scope, Tsuboyama '802 provides only a very few specific examples of actually synthesizing and testing such materials. Not all of the compounds encompassed by Tsuboyama's general chemical formula, not even all of the 760 compounds referenced in the disclosure, can successfully be prepared using methods taught by Tsuboyama '802 or otherwise known in the art. Furthermore, not all of those compounds will produce a sufficient luminescent effect under normal operating conditions (including possible chemical interfering effects) to be useful in electroluminescent applications.

In assessing the prior art teachings, it is important to appreciate that the field of electroluminescence is a relatively young, imprecise, and still developing

technology. There is still only limited predictability about how changing various chemical components of an electroluminescent material will likely affect such critical performance variables as luminescent response, intensity, color and stimulation range. To a large extent, this remains a science of trial-and-error, and an overly expansive disclosure lacking a commensurately complete demonstration of successful synthesis and utility should be treated with restraint and skepticism. H.G. Wells's famous science fiction novel "A Time Machine" was, after all, not a novelty-depriving anticipation of all future, truly operable devices of this type.

In this case, Tsuboyama '802 discloses no more than the theoretical possibility that materials encompassed by Tsuboyama's general chemical formula might exist, might be able to be synthesized, and might exhibit electroluminescent properties. No detailed directions are provided by Tsuboyama '802 for synthesizing any compound of the particular type claimed in this application, and no synthesis route is even suggested. All of Tsuboyama's actual examples employ quadridentate heteroaromatic polycyclic ligands. Nothing in Tsuboyama '802 indicates whether the chemically distinct quadridentate ketone-based ligands (the type claimed in this application), such as 3,4-diacetylhexane-2,5-dione, will have appropriate electroluminescent properties. Electroluminescent properties cannot reliably be predicted based on any currently accepted scientific knowledge in this field; it is ascertainable only by experiment. Nothing in Tsuboyama '802 or other art in this field teaches whether the specific class of compounds claimed in this application would exhibit useful electroluminescence because, among other reasons, it is known that self-quenching or other chemical/electrical effects can interfere in unpredictable ways with

electroluminescence (see, for example, the discussion of theoretical aspects of the Tsuboyama '802 invention at paragraphs [0047] through [0056]).

3. Differences Between Tsuboyama '802 Examples and the Claimed Iridium Compounds

Of the hundreds of materials theoretically encompassed by the Tsuboyama '802 disclosure, only two electroluminescent compounds according to Tsuboyama's general chemical formula having some commonalities with the claimed iridium compounds are offered as Examples, as represented by the chemical formulas at paragraphs [0095] and [0099] of Tsuboyama '802. But, in each of these two example compounds, the central quadridentate ligands are closely chemically related to the phenylpyrimidine ligands at either end, and they bind to the linking iridium atoms in substantially the same way as those end ligands. Nearly all of the other central ligands taught by Tsuboyama '802 are also quadridentate heteroaromatic structures comprising linked aromatic rings, and these would also be expected to bind to iridium in essentially the same way as the phenylpyrimidine end ligands and the quadridentate central ligands illustrated in the formulas of paragraphs [0095] and [0099]. By contrast, the central quadridentate ligands according to the present claims differ significantly, both chemically and electronically, from the types of central ligands in the formulas of paragraphs [0095] and [0099] of Tsuboyama '802.

First, the central ligands according to the present claims contain no aryl ring structures. Second, the central ligands according to the present claims bond to the linking iridium atoms on each side only by means of oxygen atoms rather than by means of nitrogen and carbon atoms as in Tsuboyama '802. Nothing in Tsuboyama

'802, or any other cited art, would lead one to believe that the bisacetylacetone-based central ligands of the pending claims would exhibit properties similar to those of the heteroaromatic central ligands that are clearly the principal focus of Tsuboyama '802. Thus, prior to the teachings of the present application, nothing other than the pure conjecture in Tsuboyama '802 would have led one of ordinary skill in this art to believe that the iridium compounds recited in the present claims would exhibit useful electroluminescent properties.

It should further be noted that the left and right halves of the quadridentate bisacetylacetone central ligands of the iridium compounds of the pending claims are linked only by a single >C-C< bond. As recited, for example, in new Claim 56, the iridium compounds of this invention are incorporated into the electroluminescent layer of an electroluminescent device by the step of vacuum evaporation onto a substrate, which typically requires temperatures of about 350-400°C. The heteroaromatic central ligands that are shown in paragraphs [0095] and [0099] of Tsuboyama '802 each have linked aryl rings bonding to the iridium atoms on each side thereof. As a result of this chemical structure, these Tsuboyama '802 compounds would be expected to exhibit greater thermal stability than the iridium compounds of the present claims which have bisacetylacetone quadridentate central ligands. Nothing in Tsuboyama '802 suggests that the type of iridium compounds of the present claims would have the necessary thermal stability to survive a vacuum sublimation step, nor was it predictable in advance of this patent application that the compounds of the present claims would be sufficiently temperature stable for a vacuum evaporation step in view of the expected weakness at the single >C-C< bond.

4. How the Other New Claims Additionally Distinguish over Tsuboyama '802

New Claims 63-66 are directed to methods of preparing electroluminescent iridium compounds according to this invention. Tsuboyama '802 does not disclose or in any way suggest the recited starting materials, the claimed synthesis steps, or that the claimed methods would be successful in producing the desired diiridium compound products (compare, for example, the different synthesis procedure taught at paragraphs [0081] through [0084] of Tsuboyama '802). In particular, it was not predictable based on the state of this art at the time of the invention that the recited bridged dichloride starting compounds would react with the recited diketones under the recited process conditions in the manner claimed to form the desired end products. Instead, these materials could, under other reaction conditions, react very differently, for example reacting only on a single side of the molecules, to yield unwanted products.

New Claims 61 and 62 are directed to electroluminescent layers having both an electroluminescent iridium compound component according to this invention and also a europium compound. Tsuboyama '802 neither discloses nor in any way suggests forming electroluminescent layers having both an electroluminescent iridium compound according to this invention and also a europium compound component.

For all of these reasons, Applicants respectfully submit that new Claims 56-70 are not anticipated under §102(e) by Tsuboyama '802.

G. Sec. 103 Rejection - Tsuboyama '802

In paragraphs 6 and 7 of the Office Action, Claims 44 and 47-51 were rejected under 35 U.S.C. §103(a) as being unpatentable over Tsuboyama '802. All of these rejected claims have been cancelled herein and replaced by new Claims 56-70. For the same reasons set forth in part (F) above, Applicants respectfully submit that new Claims 56-70 are patentable over Tsuboyama '802.

As acknowledged by the Examiner in paragraph 7 of the Office Action, “Tsuboyama et al. do not disclose a specific example of a device comprising any of compound Nos. 211-225 and 269-275 in [an electroluminescent] device...” Because of the unpredictability in this field coupled with Tsuboyama’s very narrow and limited Examples, as previously argued, the subject matter of the pending claims would not have been “obvious” to one of ordinary skill in this art at the time of the invention.

H. Sec. 103 Rejection - Tsuboyama '802 / Kathirgamanathan '037

In paragraph 8 of the Office Action, Claims 38-41 were rejected under 35 U.S.C. §103(a) as being unpatentable over Tsuboyama '802 in view of international patent publication WO 98/58037 (Kathirgamanathan '037). All of these rejected claims have been cancelled herein and replaced by new Claims 56-70. Applicants respectfully submit that new Claims 56-70 are patentable over the combination of Tsuboyama '802 and Kathirgamanathan '037.

The Examiner has cited Kathirgamanathan '037 as showing electroluminescent europium complexes. But, Kathirgamanathan '037 does not make up for the deficiencies of Tsuboyama '802 as the principal reference relative to new

Claims 56-70 for the reasons discussed in parts (F) and (G) above. Furthermore, nothing in Tsuboyama '802 or Kathirgamanathan '037 teaches or suggests forming electroluminescent layers with both an iridium compound according to the present claims and the claimed europium complex. Applicants respectfully submit that it would not have been obvious at the time of this invention to select and use the two particular claimed materials in forming an electroluminescent layer.

I. Sec. 103 Rejection - Tsuboyama '802 / Mori '489

In paragraph 9 of the Office Action, Claims 38-41 were rejected under 35 U.S.C. §103(a) as being unpatentable over Tsuboyama '802 in view of U.S. Pat. No. 5,281,489 (Mori '489). All of these rejected claims have been cancelled herein and replaced by new Claims 56-70. Applicants respectfully submit that new Claims 56-70 are patentable over the combination of Tsuboyama '802 and Mori '489.

The Examiner cited Mori '489 as showing certain types of hole transporting materials which the Examiner acknowledged are not shown in Tsuboyama '802. First, new Claims 56-70 do not recite the subject hole transporting materials taught by Mori '489. Accordingly, this ground of rejection is now considered moot. Furthermore, Mori '489 does not otherwise make up for the deficiencies of Tsuboyama '802 as the principal reference relative to new Claims 56-70 for the reasons discussed in parts (F) and (G) above.

J. Sec. 103 Rejection - Tsuboyama '802 / Lamansky '441

In paragraph 10 of the Office Action, Claims 38-41 were rejected under 35 U.S.C. §103(a) as being unpatentable over Tsuboyama '802 in view of U.S. Patent

Publication No. US 2002/0182441 (Lamansky '441). All of these rejected claims have been cancelled herein and replaced by new Claims 56-70. Applicants respectfully submit that new Claims 56-70 are patentable over the combination of Tsuboyama '802 and Lamansky '441.

The Examiner cited Lamansky '441 as showing certain types of multilayered device structures which the Examiner acknowledged are not shown in Tsuboyama '802. First, new Claims 56-70 do not recite the subject multilayered device structures taught by Lamansky '441. Accordingly, this ground of rejection is now considered moot. Furthermore, Lamansky '441 does not otherwise make up for the deficiencies of Tsuboyama '802 as the principal reference relative to new Claims 56-70 for the reasons discussed in parts (F) and (G) above.

K. Miscellaneous – Spelling Errors

In paragraph 11 of the Office Action, the Examiner noted spelling errors in Claims 35 and 55. Applicants thank the Examiner for bringing this matter to their attention. Claims 35 and 55 have been cancelled herein, and the subject chemical name has been correctly spelled in new Claims 56-70.

Application No. 10/540,732
Amendment and Response

PATENT
Attorney Docket No.: LUC-015

SUMMARY AND CONCLUSIONS

For all of the foregoing reasons, Applicants respectfully submit that Claims 56-70 now pending in this application are in condition for Allowance, and an early notice thereof is earnestly requested.

Respectfully submitted,



David Silverstein
Registration Number 26,336
Attorney for Applicant

Date February 23, 2009
Andover-IP-Law
44 Park Street, Suite 300
Andover, MA 01810
Telephone: (978) 470-0990
Facsimile: (978) 470-0993